

**Amendments to the Claims:**

This listing of claims replaces all prior versions of the claims in the patent application:

Claims 1-2 (canceled)

Claim 3 (currently amended):           A method of interpolating image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising the steps of:

- (a)     providing a first filter having a sharp interpolation characteristic;
- (b)     providing a second filter having a smooth interpolation characteristic;
- (c)     interpolating a selected image position in the image using the first filter to generate a sharp interpolation output value;
- (d)     interpolating the selected image position in the image using the second filter to generate a smooth interpolation output value;
- (e)     calculating a different weighting coefficient for the output of each filter by estimating a high frequency level at the interpolated selected image position and calculating the weighting coefficients based on the estimated image high frequency level; and
- (f)     selectively combining the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image, wherein the weighting coefficient  $\alpha$  for the first filter output is calculated according to the relation:

$$\alpha = \min(1, \max(0, (\varphi - T_1)/(T_2 - T_1)))$$

wherein  $\phi$  is the image high frequency level estimated for the given interpolation position,  $T_1$  and  $T_2$  are two pre-determined threshold values where  $T_2 > T_1 \geq 0$ ; and

the weighting coefficient for the second filter output is  $(1 - \alpha)$ .

Claims 2-14 (canceled)

Claim 15 (previously presented): A method of interpolating image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising the steps of:

- providing a first filter having a sharp interpolation characteristic;
- providing a second filter having a smooth interpolation characteristic;
- each of the filters comprises a  $N$ -tap  $M$ -phase polyphase filter;
- interpolating a selected image position in the image using the first filter to generate a sharp interpolation output value;
- interpolating a selected image position in the image using the second filter to generate a smooth interpolation output value;
- calculating a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position based on image high frequency components measured at original image pixels neighboring the selected image position, and calculating the weighting coefficients based on the estimated image high frequency level;

selectively combining the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image;

wherein the image high frequency component  $\phi_i$  at each of the original image pixels is measured according to the relation

$$\phi_i = |p_i - 0.5 * (p_{i-1} + p_{i+1})|$$

wherein  $p_i$  is original image pixel value where image high frequency component is to be measured, and  $p_{i-1}$  and  $p_{i+1}$  are original image pixel values of the neighboring pixels.

Claim 16 (original): The method of claim 15, wherein the image high frequency level  $\phi$  at the selected image position is estimated according to the relation:

$$\phi = \sum_{i=-\frac{N}{2}+1}^{\frac{N}{2}} (0.5 * (f_{-i+1}^j + g_{-i+1}^j) * \phi_i)$$

wherein  $\phi_i$ ,  $i = -\frac{N}{2} + 1, \dots, 0, \dots, \frac{N}{2}$  are the image high frequency components calculated at the original image pixels that are within the filtering range of interpolation to the selected image position,  $f_i^j$  and  $g_i^j$  are filter coefficients of sub-filters  $f^j$  and  $g^j$  for the first filter and the second filter, respectively, and  $j$  is the interpolation phase for the selected image position.

Claim 17 (canceled)

Claim 18 (previously presented): A method of interpolating image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising the steps of:

providing a first filter having a sharp interpolation characteristic;

providing a second filter having a smooth interpolation characteristic;

each of the filters comprises a  $N$ -tap  $M$ -phase polyphase filter;

interpolating a selected image position in the image using the first filter to generate a sharp interpolation output value;

interpolating a selected image position in the image using the second filter to generate a smooth interpolation output value;

calculating a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position based on image high frequency components measured at original image pixels neighboring the selected image position, and calculating the weighting coefficients based on the estimated image high frequency level;

selectively combining the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image;

wherein the image high frequency level  $\varphi$  at the selected image position is estimated according to the relation:

$$\varphi = d_1 * \phi_0 + d_0 * \phi_1$$

wherein  $\phi_0$  and  $\phi_1$  are the image high frequency components calculated at the two closest original image pixels,  $d_0$  and  $d_1$  are the distances between the selected interpolation position and the two closest original image pixel and the distance between two neighboring original image pixels is assumed to be 1, such that  $d_0 + d_1 = 1$ .

Claim 19 (canceled)

Claim 20 (previously presented): A method of interpolating image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising the steps of:

- providing a first filter having a sharp interpolation characteristic;
- providing a second filter having a smooth interpolation characteristic;
- each of the filters comprises a  $N$ -tap  $M$ -phase polyphase filter;
- interpolating a selected image position in the image using the first filter to generate a sharp interpolation output value;
- interpolating a selected image position in the image using the second filter to generate a smooth interpolation output value;
- calculating a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position based on image high frequency components measured at original image pixels neighboring the selected image position, and calculating the weighting coefficients based on the estimated image high frequency level;

selectively combining the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image; and

wherein the image high frequency level  $\phi$  at the selected image position is estimated according to the relation:

$$\phi = \sum_{i=-\frac{N}{2}+1}^{\frac{N}{2}} (0.5 * (f_{-i+1}^j + g_{-i+1}^j) * \phi_i)$$

wherein  $\phi_i$ ,  $i = -\frac{N}{2} + 1, \dots, 0, \dots, \frac{N}{2}$  are the image high frequency components calculated at the original image pixels that are within the filtering range of interpolation to the selected image position,  $f_i^j$  and  $g_i^j$  are the filter coefficients of sub-filters  $f^j$  and  $g^j$  for the first filter and the second filter, respectively, and  $j$  is the interpolation phase for the selected image position.

Claim 21 (canceled)

23. (Currently amended) An interpolation system that interpolates image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising:

(a) a first filter having a sharp interpolation characteristic, the first filter interpolating a selected image position in the image to generate a sharp interpolation output value;

(b) a second filter having a smooth interpolation characteristic, the second filter interpolating the selected image position in the image to generate a smooth interpolation output value;

(c) a controller that calculates a weighting coefficient for the output of each filter by estimating a high frequency level at the interpolated selected image position, and calculating a weighting coefficient for the output of the filter based on the estimated image high frequency level; and

(d) a combiner that selectively combines the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image, wherein the controller calculates the weighting coefficient  $\alpha$  for the first filter output according to the relation:

$$\alpha = \min(1, \max(0, (\varphi - T_1)/(T_2 - T_1)))$$

wherein  $\varphi$  is the image high frequency level estimated for the given interpolation position,  $T_1$  and  $T_2$  are two pre-determined threshold values where  $T_2 > T_1 \geq 0$ , whereby that the weighting coefficient for the second filter output is  $(1 - \alpha)$ .

Claims 24-34 (canceled)

Claim 35 (previously presented): An interpolation system that interpolates image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising:

a first filter having a sharp interpolation characteristic, the first filter interpolating a selected image position in the image to generate a sharp interpolation output value;

a second filter having a smooth interpolation characteristic, the second filter interpolating the selected image position in the image to generate a smooth interpolation output value;

wherein each of the first and second filters comprises a polyphase filter, and each of the polyphase filters comprises a  $N$ -tap  $M$  phase polyphase filter;

a controller that calculates a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position, and calculating a weighting coefficient for the output of the filter based on the estimated image high frequency level such that the image high frequency level at the selected image position is estimated based on image high frequency components measured using a high-pass filtering process at original image pixels neighboring the selected image position; and

a combiner that selectively combines the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image;

wherein the image high frequency component  $\phi_i$  at each of the original image pixels is measured according to the relation:

$$\phi_i = |p_i - 0.5 * (p_{i-1} + p_{i+1})|$$

wherein  $p_i$  is original image pixel value where image high frequency component is to be measured, and  $p_{i-1}$  and  $p_{i+1}$  are values of its neighboring pixels.

Claim 36 (original): The system of claim 35, wherein the image high frequency level  $\varphi$  at the selected image position is estimated according to the relation:

$$\varphi = \sum_{i=-\frac{N}{2}+1}^{\frac{N}{2}} (0.5 * (f_{-i+1}^j + g_{-i+1}^j) * \phi_i)$$

wherein  $\phi_i$ ,  $i = -\frac{N}{2} + 1, \dots, 0, \dots, \frac{N}{2}$  are the image high frequency

components calculated at the original image pixels that are within the filtering range of interpolation to the selected image position,  $f_i^j$  and  $g_i^j$  are filter coefficients of sub-filters  $f^j$  and  $g^j$  for the first filter and the second filter, respectively, and  $j$  is the interpolation phase for the selected image position.

Claim 37 (canceled)

Claim 38 (previously presented): An interpolation system that interpolates image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising:

a first filter having a sharp interpolation characteristic, the first filter interpolating a selected image position in the image to generate a sharp interpolation output value;

a second filter having a smooth interpolation characteristic, the second filter interpolating the selected image position in the image to generate a smooth interpolation output value;

wherein each of the first and second filters comprises a polyphase filter, and each of the polyphase filters comprises a  $N$ -tap  $M$  phase polyphase filter;

a controller that calculates a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position, and calculating a weighting coefficient for the output of the filter based on the estimated image high frequency level such that the image high frequency level at the selected image position is estimated based on image high frequency components measured at original image pixels closest to the selected image position;

a combiner that selectively combines the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image;

wherein the image high frequency level  $\varphi$  at the selected image position is estimated according to the relation:

$$\varphi = d_1 * \phi_0 + d_0 * \phi_1$$

wherein  $\phi_0$  and  $\phi_1$  are the image high frequency components calculated at the two closest original image pixels,  $d_0$  and  $d_1$  are the distances between the selected interpolation position and the two closest original image pixels, the distance between two neighboring original image pixels is assumed to be 1, such that  $d_0 + d_1 = 1$ .

Claim 39 (canceled)

Claim 40 (previously presented): An interpolation system that interpolates image positions in an original image to produce an interpolated output image, wherein the original image is represented by digital input pixel data, comprising:

a first filter having a sharp interpolation characteristic, the first filter interpolating a selected image position in the image to generate a sharp interpolation output value;

a second filter having a smooth interpolation characteristic, the second filter interpolating the selected image position in the image to generate a smooth interpolation output value;

wherein each of the first and second filters comprises a polyphase filter, and each of the polyphase filters comprises a  $N$ -tap  $M$  phase polyphase filter;

a controller that calculates a weighting coefficient for the output of each filter by estimating the image high frequency level at the selected image position, and calculating a weighting coefficient for the output of the filter based on the estimated image high frequency level such that the image high frequency level at the selected image position is estimated based on image high frequency components measured at original image pixels neighboring the selected image position;

a combiner that selectively combines the output values from the filters as a function of the weighting coefficients, to generate an interpolation output value for the selected image position of an interpolated output image;

wherein the image high frequency level  $\varphi$  at the selected image position is estimated according to the relation:

$$\varphi = \sum_{i=-\frac{N}{2}+1}^{\frac{N}{2}} (0.5 * (f_{-i+1}^j + g_{-i+1}^j) * \phi_i)$$

wherein  $\phi_i$ ,  $i = -\frac{N}{2} + 1, \dots, 0, \dots, \frac{N}{2}$  are the image high frequency

components calculated at the original image pixels that are within the filtering range of interpolation to the selected image position,  $f_i^j$  and  $g_i^j$  are the filter coefficients of sub-filters  $f^j$  and  $g^j$  for the first filter and the second filter, respectively, and  $j$  is the interpolation phase for the selected image position.